

SECTION 02513
BITUMINOUS CONCRETE PAVEMENT

PART 1 - GENERAL

0.1 DESCRIPTION OF WORK

- A.** Work Included: This Section specifies the construction of bituminous concrete pavement on prepared subgrade or aggregate subbase or base course, on bridges, and on existing pavement, to the lines, grades, compacted thickness, and cross sections indicated.

0.2 QUALITY ASSURANCE

- A.** The Authority reserves the right to perform inspections and testing at the plant and in the field at any time during the execution of work.

0.3 Quality Control

- A.** The contractor shall engage the services of a qualified independent testing agency approved by the Authority to perform quality-control testing in the field.
- B.** Job Mix Formulae
1. The composition limits specified in Table 02513-C at the end of this Section are master ranges of tolerances of materials in general. In order to obtain standard texture, density, and stability, furnish to the Engineer for approval a specific job mix formula for the particular uniform combination of materials and sources of supply to be used on each project. Establish the job mix formula in accordance with the requirements of the Massachusetts Highway Department Section M3 Standards.
 2. Should a change of sources of materials be made, furnish a new job mix formula for approval before using the new material.
 3. Two or more job mix formulae may be approved for a particular plant; however, only material conforming to one job mix formula will be permitted to be used on any given day. If the Contractor elects to furnish bituminous concrete from more than one plant, the job mix formulae shall be adhered to by all plants.
 4. When unsatisfactory results or other conditions make it necessary, the Engineer may establish new job mix formulae.
- C.** Methods of Sampling and Testing

1. Performance Graded Asphalt Binder
 - a. Viscosity: ASTM D4402.
 - b. Dynamic Shear: AASHTO TP5.
 - c. Flash Point: AASHTO T48.
 - d. Rolling Thin Film Over Test: AASHTO T240.
 - e. Mass Change %: AASHTO T240.
 - f. PAV Aging: AASHTO PP1.
 - g. Specific Gravity: ASTM D 3142.
 - h. Creep Stiffness and M-Value: AASHTO TP1.
2. Cutback Asphalt
 - a. Viscosity: ASTM D 2170.
 - b. Flash Point: ASTM D 3143.
 - c. Distillation: ASTM D 402.
 - d. Water in Asphalt: AASHTO T55.
 - e. Specific Gravity: AASHTO T228.
3. Emulsified Asphalt: ASTM D 977.
4. Mineral Aggregates and Filler:
 - a. Sieve Analysis, Aggregates: ASTM C 136.
 - b. Sieve Analysis, Mineral Filler: ASTM D 242.
 - c. Unit Weight of Aggregate: ASTM C 29.
 - d. Material Passing No. 200 Sieve: ASTM C 117.
 - e. Abrasion of Coarse Aggregate: ASTM C 131.
 - f. Soundness of Aggregates: ASTM C 88.
 - g. Specific Gravity, Coarse Aggregate: ASTM C 127.
 - h. Specific Gravity, Fine Aggregate: ASTM C 128.
 - i. Specific Gravity, Mineral Filler: AASHTO T100 to T133
5. Bituminous Concrete Mixtures:
 - a. Density: AASHTO T166.
 - b. Compaction: ASTM D 2950.

D. Composition and Compaction Acceptance Tests

1. Where plant inspection is maintained, bituminous concrete will be acceptable for use if the specified tests from samples obtained at the production plant indicate conformance to the approved job mix formula.
2. For determination of pavement density, perform in-place density testing by the Nuclear Density Method, ASTM D 2950. The number of tests shall be determined by the MBTA QA lab.
3. The Authority may also require bituminous cores to determine in-place density.

PART 2 - PRODUCTS

0.1 MATERIALS

- A.** Performance Graded Asphalt Binder: AASHTO M320, grade as indicated, except that the requirements listed under Table 02513-A shall apply.

B. Cutback Asphalts

1. Medium-Curing: AASHTO M82, grade as indicated.

C. Bituminous Emulsions

1. Asphaltic Emulsions: AASHTO M140, grade as indicated. Use grade RS-1 for prime coat or tack coat.
2. Cationic Emulsified Asphalt: AASHTO M208, grade as indicated.
3. Clay-Type Asphalt Emulsion: A mineral colloid type of asphalt emulsion containing no chemical emulsifiers and meeting the following requirements:
 - a. Percent water, per AASHTO T59: 40 to 55
 - b. Percent residue by evaporation, per AASHTO T59: 45 to 60
 - c. Percent ash in residue, per ASTM D1010: 5 to 15
 - d. Curing time, per Massachusetts DPW standard test procedures: firm set in 48 hours maximum
 - e. Resistance to water, per Massachusetts DPW standard test procedures: no re-emulsification.
4. Protective Seal Coat Emulsion: a homogeneous emulsion consisting of coat tar pitch dispersed in water by means of a mineral colloid, containing no asphaltic materials or chemical emulsifiers; capable of overcoming any separation or coagulation of its components by moderate stirring; meeting the following requirements:
 - a. Percent Water, per AASHTO T59: 50 maximum
 - b. Percent non-volatile matter, per ASTM D1010: 48 minimum
 - c. Percent ash in non-volatile matter, per ASTM D1010: 20 to 45
 - d. Percent solubility on non-volatile matter in carbon disulfide: 40 minimum
 - e. Resistance to water, per ASTM D466: no blistering, loss of adhesion, or re-emulsification
 - f. Resistance to petroleum solvents, per ASTM D466 with solvents substituted for water: no penetration nor loss of adhesion.

D. Asphalt Anti-Stripping Additive

1. General: An additive to asphalt to assist in the coating of wet aggregate and to increase the resistance of the bituminous coating to stripping in the presence of water; shall be chemically inert to asphalt (heat stable) and when blended with asphalt shall withstand storage at a temperature of 400 degrees F for extended periods without loss of effectiveness.
2. Composition: An organic chemical compound free from inorganic mineral salts or inorganic mineral soaps, containing no ingredient harmful to the bituminous material or to the operator, and not appreciably altering the specified characteristics of the bituminous material; chemically inert to asphalt.
3. Heat Stability: The compound shall retain its effectiveness after heating in asphalt according to the prescribed method for 24 hours at 350 degrees F.

4. Resistance to Stripping. Treated Bitumen shall coat wet aggregate and shall retain at least 90 percent of the coating after 24 hours of static immersion. There shall be no loss of the retained coating after the immersion has been extended to one week.

E. Coarse Aggregate

1. General: Clean, crushed rock consisting of the angular fragments obtained by breaking and crushing shattered natural rock, free from a detrimental quantity of thin or elongated pieces, and free from dirt or other objectionable materials; having a percentage of wear of not more than 30; surface dry and having a moisture content of not more than 0.5 percent after drying. The use of crushed gravel stone will not be permitted.
2. Gradation: Blended from the stone sizes listed in Table 02513-B. Each stone size shall meet its respective gradation as tabulated in Table 02513-B. Sizes other than primary stone sizes may be used providing they are separately introduced on the cold feed belt and can be shown to be an improvement to the mix. Such usage shall require the prior written approval of the Engineer.

F. Fine Aggregate

1. General: Natural or stone sand or a blend thereof; or a blend of natural sand and stone screenings, or a blend of stone, sand and stone screenings;
 - a. Natural Sand: Clean, inert, hard durable grains of quartz or other hard durable rock, free of loam, clay, surface coatings or other deleterious substances.
 - b. Stone Sand: Process from the stone screenings, of either a primary or secondary crusher to produce a product that when used alone or blended in any combination with natural sand shall meet the specified gradation requirements. Wash plant or other equipment used for processing stone sand shall be as accepted by the Engineer.

- G.** Mineral Filler: Portland cement, limestone dust, hydrated lime, stone float, or stone dust, 100 percent passing a No. 50 sieve and not less than 65 percent passing a No. 200 sieve. Stone dust shall be produced from crushed ledge stone and shall be the product of a secondary crusher so processed as to deliver a product of uniform grading.

- H.** Reclaimed Asphalt Pavement (RAP): Reclaimed Asphalt Pavement (RAP) shall consist of the material obtained from the highways or streets by crushing, milling, or planing existing hot mix asphalt pavements. This material shall be transported to the hot mix asphalt production facility yard and processed through an appropriate crusher so that the resulting material will contain no particles larger than the maximum aggregate size of the hot mix asphalt mixture in which it will be used. The material shall be stockpiled on a free draining base and kept separate from virgin

aggregates. The material contained in the RAP stockpiles shall have a reasonably uniform gradation from fine to coarse and shall be protected from accumulation of excessive moisture and shall not be contaminated by foreign materials. The use of RAP will be permitted provided that the end product is in conformance with the approved job-mix formula. The proportion of RAP to virgin aggregate for base course mixtures and intermediate course mixtures shall be limited to a maximum of 40% for drum mix plants and 20% for modified batch plants. The maximum amount of RAP for surface course mixtures shall be 10%.

0.2 CLASS I BITUMINOUS CONCRETE MIXES

- A.** Provide Class I bituminous concrete mixtures composed of mineral aggregate, mineral filler if required bituminous material, and anti-stripping additive if required, proportioned as specified herein to conform to the composition by weight tabulated in Table 02513-C and in the approved job mix formulae.
- B.** Use sufficient mineral filler to correct any deficiencies in grading of fine aggregate.
- C.** Anti-stripping additive, if required, shall be incorporated and thoroughly dispersed in the bituminous material in an amount equal to the percent by weight established by the Authority's Materials Testing Laboratory. This percent will be based on the efficiency of the additive as determined by laboratory tests. No modification of the established additive concentration will be permitted because of the use of hydrophobic aggregate. The Authority reserves the right to establish as minimum the percentage of additive required. Blend additive in the refinery with the asphalt in the presence of the Inspector.
- D.** The percentages stated herein and in Table 02513-C are stated as proportional percentages of integral total aggregate for the mix.
- E.** Furnish Intermediate Course, with anti-stripping additive, for use as protective (bottom) course of pavements on bridges, and elsewhere as indicated.
- F.** Furnish Patching Mix with one percent hydrated lime.

PART 3 - EXECUTION

0.1 PLANT REQUIREMENTS

- A.** General: The plant used in the production of bituminous concrete shall comply with AASHTO M156, subject to the following additional requirements.

B. Plant Scales

1. Scales for measuring materials into the mixtures shall be springless dial type and shall be of standard make and design. Scale graduations and markings shall be plainly visible and dials shall be so located as to be easily readable from the operator's normal work station by direct sight or through repeating dials. Parallax effects shall be reduced to the practical minimum with clearance between indicator index and scale graduations not exceeding 0.06 inch. Dials shall be equipped with a full complement of adjustable index pointers for marking the required weight of each material to be weighed into the batch.
2. Digital scales will be either electric/mechanical (load cell and lever system) or fully electronic (all load cell). Digital indicators shall be of standard make and design. Scale graduations and capacity shall be plainly visible on the faceplate of the indicator, if panel mounted. If the unit is of desktop or wall-mount variety, a data sticker shall be located on the side of the unit. Indicators must be located as to be easily readable from the operator's normal workstation by sight.
3. Bitumen scales shall be accurate to 0.05 percent, have minimum graduations not greater than 0.025 percent, and shall be readable and sensitive to 0.0125 percent or less. Scales for any weigh box or hopper shall be accurate to 0.5 percent, have minimum graduations not greater than 0.5 percent and shall be readable and sensitive to 0.25 percent or less. The preceding percentages for both bitumen and aggregate scales are based on the maximum total batch weight of the mixtures.

C. Testing of Scales

1. All plant scales, including truck scales, shall be tested at the expense of the Contractor by a competent scale technician as follows:
 - a. Annually prior to use in Authority work.
 - b. At intervals of not more than 90 calendar days.
 - c. At any time ordered by the Engineer.
2. A cradle or platform approved by the Engineer for each scale and at least ten standard fifty-pound test weights shall be provided for testing scales whenever directed by the Engineer. The use of a set of test weights for two or more plants will be permitted only when they can be made readily available with no more than an hour's notice.

D. Automated Batching

1. Automatic proportioning. Batch type mixing plants shall be equipped with approved automatic proportioning devices. Such devices shall include equipment for accurately proportioning batches containing the various components of the mixture by weight in the proper sequence and for controlling the sequence and timing of mixing operations. Interlocks shall be provided which will hold or delay the automatic batch cycling whenever the batched quantity of any component is not within the specified weight tolerance, when any

aggregate bin becomes empty or when there is a malfunction in any portion of the control system. The weight setting and time controls shall be so equipped that they may be locked when directed by the Engineer.

2. Automatic Recordation. Recordation equipment shall be provided. Each recorder shall include an automatic printer system. The printer shall be so positioned that the scale dial and the printer can be readily observed at one location by the plant inspector. Use of repeating dials or an additional printer to achieve this condition will be permitted. The printer shall print, in digital form, on a delivery ticket the following data:
 - a. Date mixed.
 - b. Time of batching.
 - c. Tare weight of aggregate weigh box.
 - d. Tare weight of bitumen weigh bucket.
 - e. Accumulative weights as batched for each bin. (Total of last bin will be aggregate total).
 - f. Weight of bitumen.
 - g. Total weight of mix in truck (Pay weight). This printed ticket shall be used in lieu of truck scale weights.
3. Equipment Failure. If at any time the automatic proportioning of recording system becomes inoperative, the plant will be allowed to batch materials manually for a period not in excess of two working days. Manual batching for longer periods will require written permission of the Engineer.
4. Batching Controls
 - a. The batching controls shall meet the following delivery tolerances with respect to the various components weighed in each batch:
 - 1) Tare Weight of Aggregate Weigh Box: + 0.5 percent of total batch weight.
 - 2) Tare Weight of Bitumen Weigh Bucket: + 0.1 percent of total batch weight.
 - 3) Individual Aggregate Components: + 1.0 percent of total batch weight.
 - 4) Combined Aggregate Components: + 1.5 percent of total batch weight.
 - 5) Mineral Filler: + 0.5 percent of total batch weight.
 - 6) Asphalt: + 0.1 percent of total batch weight.
 - b. The total weight of the batch shall not vary more than plus or minus 2 percent from the theoretical design weight.
 - c. If directed by the Engineer, provisions shall be made for locking controls against tampering.

E. Plant Laboratory

1. A building shall be furnished at the site of the producing plant suitable for the housing and use of equipment necessary to carry on the various tests required and for recording and processing test

- results. This building shall be for the exclusive use of the Engineer or his representatives for testing and recording purposes.
2. The building shall have a minimum floor area of 100 square feet; the least dimension to be 6 feet. Windows and doors shall be adequately screened; satisfactory lighting, heating and water shall be supplied. A table, chairs, desk and work bench shall be provided. Provision shall be made for the safe performance of extraction test determinations by providing an adequate exhaust fan and suitable means of disposing of used solvent and other waste.
 3. If the Engineer permits, the plant laboratory may be part of another building in which case it shall be entirely partitioned off from the remainder of such building.
 4. Testing equipment shall be furnished as follows and installed in the building for use in testing the materials and mixtures supplied by the Plant for the work:
 - a. One Approved Rotary Extractor.
 - b. One Coarse Aggregate Sieve Shaker, power driven with a minimum clear sieve area of 324 square inches. The shaker shall be attached to a firm anchorage.
 - c. One each of the following square opening screens for coarse aggregate shaker: 2 inch, 1-1/2 inch, 1 inch, 3/4 inch, 1/2 inch, 1/8 inch, No. 4 and No. 8.
 - d. One Fine Aggregate Sieve Shaker, power driven and independent of the coarse aggregate shaker, for eight inch minimum diameter sieves.
 - e. One each of the following standard eight inch minimum diameter square opening sieves: 3/4 inch, 1/2 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, No. 50, No. 100, and No. 200, with pan and cover.
 - f. One Sample Splitter with a minimum capacity of one cubic foot. It shall be the clam shell type and the chute width shall be adjustable from a minimum of 1/2 inch up to 2 inches.
 - g. One Solution Balance, 20 kilogram capacity, weighing directly to 1 gram, with two weighing beams and a taring beam; tare capacity to be 2 kilograms; weighing beams to read 1000 grams by 100 gram divisions and 100 grams by 1 gram division. Additional matching weights (one 1 kg., two 2 kg., one 5 kg., and one 10 kg.) shall be provided to fulfill the capacity of 20 kilograms. The platform to be 11 inches in diameter.
 - h. One Approved Scale with a minimum capacity of 2000 grams and with a sensitivity of 0.50 grams
 - i. Two Approved Dial Type Thermometers, range 50 degrees F. to 500 degrees F.
 - j. One Approved Hot Plate
 5. Approval of a plant will be contingent upon approval of the aforementioned requirements for Plant Laboratory, including the building and appurtenances, furnishings, facilities including heat, light, power and water, the testing equipment, and any other incidentals.

- F.** Sampling facilities. Adequate and convenient sampling facilities shall be provided to allow the Inspector to obtain representative samples from the full width and depth of the discharge area of each aggregate bin. The sampling tray shall be structurally supported during the sampling operation. Access to the sampling facilities shall be provided requiring no more difficulty than that to climb a ladder leading to a secure platform with railings.
- G.** Inspection. The Engineer or his authorized representative shall have access at any time to all parts of the plant for:
 - 1. Inspections of the conditions and operations of the plant.
 - 2. Confirmation of the adequacy of the equipment in use.
 - 3. Verification of the character and proportions of the mixture.
 - 4. Determination of temperatures being maintained in the preparation of the mixtures.
 - 5. Inspection of incidental related procedures.

0.2 PREPARATION OF MIXTURES

- A.** Preparation of Asphalt Cement. Place bituminous materials in the mixer at a temperature between 275 and 375 degrees F., as directed.
- B.** Preparation of Mineral Aggregate. Thoroughly dry and heat aggregates before placing them in the mixer. Control the temperature of the aggregates so that the temperature of the complete mixture shall be within the range specified in paragraph C. below.
- C.** Preparation of Bituminous Concrete Mixtures. Combine the heated and dried aggregates and mineral filler and convey them into the mixer in the proportionate amounts of each size required to meet the job mix formula. After these materials have been mixed for the specified dry-mixing time, add the asphalt cement and mix for the specified wet-mixing time. Measure asphalt cement by weight or by an approved metering device. The temperature of the mixture when discharged shall be between 275 and 325 degrees F.

0.3 TRANSPORTATION AND DELIVERY OF MIXTURES

- A.** Vehicles for transportation of mixtures from the plant to the jobsite shall be clean of all foreign materials, tight, and evenly and lightly coated with a suitable thin oil or approved soap solution. No excess of lubricant shall be allowed to accumulate in low spots in the body. When necessary, vehicles shall be insulated so that the mixture is delivered for placement at the proper temperature.
- B.** Arrange dispatching of trucks from the plant so that all material which is delivered to the jobsite during any day shall be placed and shall have

received final compaction before nightfall of the same day, unless satisfactory artificial light is provided.

- C. Do not transport mixtures such a distance that segregation of the ingredients takes place or that any crust is formed on the top, bottom, or sides of the mixture which will not crumble or flatten out when the mixture is dumped or which might otherwise be deleterious to the mixture in place on the work.
- D. During transportation of the mixture from the plant to the spreader at the jobsite, keep the mixture fully covered at all times with canvas or other suitable material of sufficient size and thickness to furnish complete protection.
- E. Deliver the mixture to the jobsite at a temperature governed by the air temperature in the shade and away from artificial heat, as follows with a tolerance of plus or minus 20 degrees F.:

1. Normal Layered Construction:

Air Temperature	Delivered Mix Temperature
35 degrees F.	300 degrees F.
40 degrees F.	290 degrees F.
65 degrees F.	280 degrees F.
90 degrees F. and Over	275 degrees F.

2. Deep Lift Paving (3 inches and over), Base and Binder Courses only:

Air Temperature	Delivered Mix Temperature
35 degrees F.	280 degrees F.
40 degrees F.	270 degrees F.
65 degrees F. and over	260 degrees F.

0.4 PRIME COAT (OR TACK COAT)

- A. Where an existing hardened surface is used as a base for new pavement, or elsewhere where the surface to receive bituminous pavement is, in the Engineer's judgment, unsatisfactory to receive the pavement, give the surface a prime coat of bituminous material of the kind and grade indicated

or directed. Where unsatisfactory conditions, requiring application of prime coat, are due to the fault of the Contractor, provide the prime coat at no additional expense to the Authority.

- B.** Clean the existing surface of all foreign matter and loose material before applying prime coat. Apply the prime coat by mechanical means at the rate indicated or directed.

0.5 SPREADING AND FINISHING

A. General

1. Place bituminous concrete in courses as indicated.
2. When an existing surface or new base, upon which the bottom course is to be laid, contains unsatisfactory irregularities, in the Engineer's judgment, eliminate such irregularities by placing and compaction of mixture, so as to furnish a surface with true contour and grade before placing any specified bottom course.
3. Paint thoroughly the contact surfaces of bridge curbing, manholes, catch basins, and other appurtenant structures in pavement, with a thin coating of bitumen immediately prior to placing any mixture against them.
4. Give special attention to proper testing of the surface of each course with a straightedge. Finished surfaces shall be even and uniform throughout.
5. Remove and replace with new mixture any mixture which becomes loose or broken, mixed with dirt, or defective in any way. Finish and compact the repaired area to conform to the surrounding area. Remove and replace areas of one square foot or more showing an excess of bitumen.
6. No mixture shall be placed unless the breakdown and intermediate rolling can be completed by the time the material has cooled at 175 degrees F., and provided that the density of the pavement attains at least 95 percent of the laboratory compacted density.

B. Spreading and Finishing Equipment

1. The equipment for spreading and finishing shall be mechanical, self powered pavers, capable of spreading and finishing the mixture to line, grade, width, and crown by means of fully automated controls for both longitudinal and transverse slope.
2. The pavers shall be equipped with hoppers and distributing screws of the reversing type to place the mixture evenly in front of adjustable screeds. They shall be equipped with a quick and efficient steering device and shall have reverse as well as forward traveling speeds.
3. The pavers shall employ mechanical devices such as equalizing runners, straight edge runners, eveners arms or other compensating devices to adjust the grade and confine the edges of the mixture to true lines. They shall be capable of spreading the mixture without segregation in layers to the depths and widths required. They shall be

- equipped with blending or joint leveling devices for smoothing and adjusting all longitudinal joints between adjacent strips or courses of the same thickness.
4. The screed shall be adjustable for profile and shall have an indicating level attached.
 5. An approved device will be required for heating the screed to the temperature required for the laying of the mixtures without pulling or marring.
 6. The term "screed" includes any "strike-off" device operated by cutting, crowding, or other practicable action, which is effective on the mixtures at permissible workable temperatures without tearing, shoving, or gouging and which produces a finished surface of the evenness and texture required.
 7. The pavers employed on projects requiring in excess of 15,000 tons shall operate by the use of a sensing grid for operation to a stringline and matching shoe for joints.
 8. The paver shall be provided with a "ski" which may be employed for paving on the previously laid bituminous concrete base, or binder as directed or permitted by the Engineer.
 9. The paver employed on deep lift construction shall be capable of satisfactorily feeding the mix without intermittent stopping during the discharge of the mix from the trucks into the paving machine.
 10. If during construction, it is found that the spreading and finishing equipment in use leaves tracks or indented areas, or produces other permanent blemishes in the pavement which are not satisfactorily corrected by the scheduled operations, the use of such equipment shall be discontinued and other satisfactory spreading and finishing equipment shall be provided.
 11. Complete all compaction rolling before the bituminous concrete temperature drops below 185 degrees Fahrenheit.

C. Machine Spreading

1. Deposit mixtures in the approved mechanical spreader, spread immediately, and strike off in a uniform layer to the full width required and to such depth that each course, when compacted, shall have the required thickness and shall conform to the indicated grade and cross section contour.
2. Deposit mixture in the center of the hoppers, exercising care to avoid overloading and spilling. Operate the pavers, while the mixture is being spread, at a speed which will produce a uniform surface texture.
3. Immediately after each course is screeded and before roller compaction is started, check the surface, adjust any irregularities, remove accumulation from the screed by rake or lute, and remove and replace any unsatisfactory spots in the course. Correct irregularities in line and grade along outside edges by addition or removal of material before the edge is rolled. Indiscriminate casting of mix on the new screeded surface, where irregularities are not evident, will not be permitted.

4. All edges shall be true and uniform.

D. Hand Spreading

1. Spreading by hand methods will be permitted only for particular locations in the work which because of irregularity, inaccessibility or other unavoidable obstacles do not allow mechanical spreading and finishing.
2. When hand spreading is permitted, place the mixture by dumping on approved steel dump sheets outside the area upon which it is to be spread; or by other approved methods. Immediately thereafter, distribute the mixture into place by means of hot shovels, and spread it with hot rakes or lutes in a loose layer of uniform density and correct depth. Tines of the rakes shall be not less than 1/2 inch longer than the loose depth of mixture, and spaces between tines shall be not less than 1 inch.
3. Do not dump loads faster than they can be properly handled by the shovelers, and do not distribute the dumped load faster than it can be properly handled by the rakers. Rake carefully and skillfully to avoid segregation and so that, after the first passage of the roller over the raked mixture, no back patching will be necessary.

0.6 COMPACTION

A. Compaction Equipment

1. After the paving mixture has been properly spread, initial compaction shall be obtained by the use of power rollers of approved design and weight per inch width of roller. The rollers shall be steel-wheeled supplemented with pneumatic-tired rollers where required, or where permitted, vibratory rollers.
2. Steel wheel rollers for initial and intermediate rolling shall have a weight of not less than 240 pounds per inch width of tread; for top course, minimum weight shall be 285 pounds per inch width of tread.
3. Pneumatic-tired rollers, when conditions warrant, shall be provided with devices capable of varying tire pressures. When the mixture being spread by each paver requires more than the minimum number of steel wheel rollers, at least one of the additional rollers for each paver shall be a pneumatic-tired roller, except where the use of a vibratory roller is permitted. When using a pneumatic-tired roller, care shall be taken that initial rolling by the steel wheel roller be restricted to one pass where upon the pneumatic-tired roller shall immediately follow the initial steel wheel rolling.
4. Vibratory steel drum rollers shall not be used on top course mix or structures. The machine shall have a device registering the number of vibrations per minute and a tachometer shall be provided to the Engineer in order to check the operation of the roller.
5. The V.P.M. on base and binder course material shall be a minimum of 1400 V.P.M. and a maximum of 1500 V.P.M., or in accordance with

the recommendations of the manufacturer, when approved by the Engineer.

6. The vibratory roller shall be operated with the vibrating drum in the direction of the paver and the vibrating action of the roller shall be completely shut off during change of direction and care exercised to start this action only when the roller is in motion. In order to prevent creeping and aggregate crushing during rolling of layered pavement, care shall be taken not to exceed one pass in the direction of the paver with vibrator in action and one return in a static condition and for deep lift pavements these passes shall not exceed two operations in each direction, except that the number of vibratory passes in either direction may be varied in order to obtain the required density.
7. A smoothing roller of either the pneumatic-tired or steel wheeled type shall be used immediately behind the last pass of the vibrating roller. The use of a vibratory roller may be suspended by the Engineer if, in his opinion, unsatisfactory results are being obtained and no further mix shall be spread until a sufficient number of approved rollers are on the project to satisfy the compaction requirements.
8. A plate shall be attached to each roller which shall show the ballasted and unballasted weight per inch width of tread.
9. The number of rollers and passes required shall be governed by the compaction results; however, at least one steel roller shall be provided for each paver employed on the paving operation. This is independent of the requirements of the pneumatic-tired roller.

B. Compaction Procedures

1. Roll the mixture longitudinally, diagonally, and transversely as may be necessary to produce the required contour for surface. Start longitudinal rolling at the side and proceed toward the center of the pavement, except on superelevated curves start at the low side and progress to the high side, overlapping on successive trips by at least 12 inches.
2. Continue the rolling so that all roller marks, ridges, porous spots, and impressions are eliminated and the surface has the required contour and grade. Maintain the motion of the rollers at all times slow enough to avoid any displacement of the hot mixture. Correct any displacement or marring of the surface resulting from reversing the direction of the roller or from any other cause.
3. To prevent adhesion with the mixture, keep the wheels of steel rollers lightly moistened with water. Excess water or oil for this purpose will not be permitted.
4. To prevent "rolloff" of the pavement edges and longitudinal joints on deep lift paving, leave the outer eight inches of the deep lift mixture unrolled until the temperature of the mix ranges between 150 and 180 degrees F., whereupon compact it with a steel roller.
5. Along curbs, structures, and all places not accessible with a roller, compact the surface thoroughly with mechanical tamping devices, smooth and true to established line, grade, and contour.

6. The densities of compacted bituminous concrete shall not be less than 95% of the density obtained from laboratory compaction of a mixture composed of the same material in like proportions or 92% maximum theoretical density of said mixture. The Authority shall conduct confirmatory testing

0.7 JOINTS

- A. Place mixture as nearly continuously as possible. Pass the roller over the unprotected end of newly placed mixture only when the placing of the course is to be discontinued for such length of time as will permit the mixture to attain initial stability. In all such cases, including the formation of joints as herein specified, provide for proper bond with the new surface for the full specified depths of the courses.
- B. Maximum length of longitudinal joint shall be such that the temperature of the mixture at the joint shall not be less than 150 degrees F. when the abutting mixture is placed.
- C. Make longitudinal and transverse joints in a careful manner, well bonded and sealed, true to line and grade. Where directed, cut back longitudinal and transverse joints to expose the full depth of the course and, when laying of the course is resumed, paint the exposed edge of the joint with a thin coat of bitumen. Carefully rake the new mixture against the joint, then thoroughly tamp and roll.
- D. In making joints along any adjoining edge such as curb, gutter, or an adjoining pavement, and after the mixture is spread by the paver, place by hand just enough of the hot material to fill any space left open. Set up these joints with the back of a rake at the proper height and level to receive the proper compaction.
- E. Stagger longitudinal joints in successive courses so that there is a minimum of one foot overlap between longitudinal joints in adjacent courses.
- F. Overlap the rolling of successive widths of courses so as to leave smooth, uniform joints and cross sections.

0.8 PAVEMENT ON BRIDGES

- A. Place Intermediate Course for protective course within 24 hours after the membrane waterproofing over the area has been placed. Do not permit vehicular traffic over any bare membrane waterproofing.
- B. Place Top Course only after curbing and edging are in place in the work.

0.9 FIELD QUALITY CONTROL

- A.** Test the plane of the finished surfaces of base, binder, and surface courses with a 16-foot straightedge, except use a 10-foot straightedge on vertical courses and on the top course of resurfaced streets which contain manhole covers, valve boxes, and the like.
- B.** Carefully apply the straightedge immediately after the first compaction by rolling, and from then on as may be necessary until and after the final compaction of the material in place. Hold the straightedge in successive positions parallel to the road centerline and in contact with the road surface; check the entire area from one side of the pavement to the other.
- C.** Correct irregularities which vary $\frac{3}{8}$ inch from a true finished surface in base and binder courses, and $\frac{1}{4}$ inch in top courses.
- D.** Irregularities which may develop before the completion of rolling and while the material is still workable, may be remedied by loosening the surface mixture and removing or adding material as necessary. Should any unsatisfactory irregularities or defects remain after final compaction, correct the defective work by removing and replacing with new material to form a true and even surface.

0.10 OPENING TO TRAFFIC

- A.** No vehicular traffic or loads shall be permitted on the newly completed pavement until adequate stability has been attained, and the material has cooled sufficiently to prevent distortion or loss of fines, and the pavement has achieved a maximum temperature of 140 degrees F.
- B.** If the climatic or other conditions warrant it, the period of time before opening to traffic may be extended at the discretion of the Engineer.

PART 4 - MEASUREMENT AND PAYMENT

0.1 MEASUREMENT

- A.** Bituminous concrete will be measured by the ton complete in place, determined by weight slips countersigned by the Engineer at time of delivery. The Schedule of Bid Prices may provide for separate measurement of the different mixtures.
- B.** Bitumen for prime coat will be measured by the gallon.

0.2 PAYMENT

- A.** Bituminous concrete and bitumen for prime coat will be paid for at the Contract unit prices for the quantities determined as specified above.

0.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0261.151	BITUMINOUS CONCRETE PAVEMENT	TN
0261.125	BITUMEN	GL

TABLE 02513 - A**SPECIFICATION REQUIREMENTS FOR PERFORMANCE GRADED ASPHALT BINDERS**

TESTS AT PG TEMPERATURE deg. C.	PG 64-22	PG 64-28	PG 52-34
Viscosity, Brookfield 135 degrees C Pa- sec.	3 Max.	3 Max	3 Max
Dynamic Shear, 10 Rad./sec. Kpa	1.00 Min.	1.00 Min.	1.00 Min.
RTFO, % Change	1.0 Max.	1.0 Max.	1.0 Max.
RTFO, Residue Dynamic Shear, KPa	2.20 Min.	2.20 Min.	2.20 Min.
PAV Residue Dynamic Shear, KPa	5,000 Max.	5,000 Max.	5,000 Max.
Creep Stiffness (s), MPa	300 Max.	300 Max.	300 Max.
M Value	0.300 Min.	0.300 Min.	0.300 Min.

TABLE 02513-B**GRADATION REQUIREMENTS FOR COARSE AGGREGATE
(PERCENT BY WEIGHT)**

Nomin al Size of Stone Sieve Size	2 in.	1-1 /2 in.	1-1 /4 in.	3 /4 in.	1 /2 in.	3 /8 in.
2-1/2"		100				
2"	90-100	100				
1-1/2"		95-100	100			
1-1/4"	25-50		85-100			
1"		35-70		100		
3/4"	0-15	0-25	10-40	90-100		
5/8"					100	

1/2"	0-5		0-8	10-50	85-100	100
3/8" No. 4 No. 8 No.16				0-20 0-5	15-45 0-15 0-5	85-100 20-50 0-15 0-5

TABLE 02513-C
MASTER RANGES FOR JOB MIX FORMULAE
(PERCENT BY WEIGHT)

Standard Sieves	Base Course	Binder Course	Intermediate Course	Top Course	Dense Mix	Surface Treatment	Patching Mix
2" 1-1/2"	100 90-100						
1" 3/4"	65-90 55-80	100 80-100	100 76-98				
1/2" 3/8"	40-65	55-80	66-86 57-77	100 80-100	100 80-100	100	100 90-100
No. 4 8	20-45 15-33	28-50 20-38	40-60 26-46	50-76 37-54	55-80 48-63	80-100 64-85	50-65 24-36
No. 16 30	8-17	8-22	17-37 11-27	26-40 17-31	36-49 24-38	46-68 26-50	14-28 8-25
No. 50 100 200 Bitumen	4-12 0-4 4-5	5-15 0-5 4.5-5.5	7-19 6-16 3-6 4.5-6.0	10-23 5-16 2-7 5.5-7.0	14-27 6-18 4-8 7-8	13-31 7-17 3-8 7-8	5-21 3-15 2-8 4-6

TABLE 02513-D
ACTION LIMITS FOR AGGREGATE GRADATIONS AND BINDER CONTENT

SIEVE DESIGNATION/BINDER CONTENT	ACTION LIMIT
Passing No.4 Sieve and Larger Sieve Sizes	JMF Target +/- 6%
Passing No. 8 Sieves	JMF Target +/- 5%
Passing No. 16 to No. 50 Sieves (Inclusive)	JMF Target +/- 3%
Passing No. 100 Sieve	JMF Target +/- 2%
Passing No. 200 Sieve	JMF Target +/- 1%
Binder	JMF Target +/-0.3%

Deviations from the final approved mix design for bitumen content and gradation of aggregates shall be within the action limits for individual measurements as specified in Table 02513-D. The limits still will apply if they fall outside the master grading band in Table 02513-C.

END OF SECTION

CONTRACT NO.
YEAR

BITUMINOUS CONCRETE PAVEMENT
02513 - 21

MBTA
REV 4/11

NOTES TO THE DESIGNER

- A.** Any request to modify or waive the specification requirements listed below must be approved in writing by the MBTA's Director of Design:
1. For pavement compaction, the minimum 95% laboratory compaction shall not be changed.